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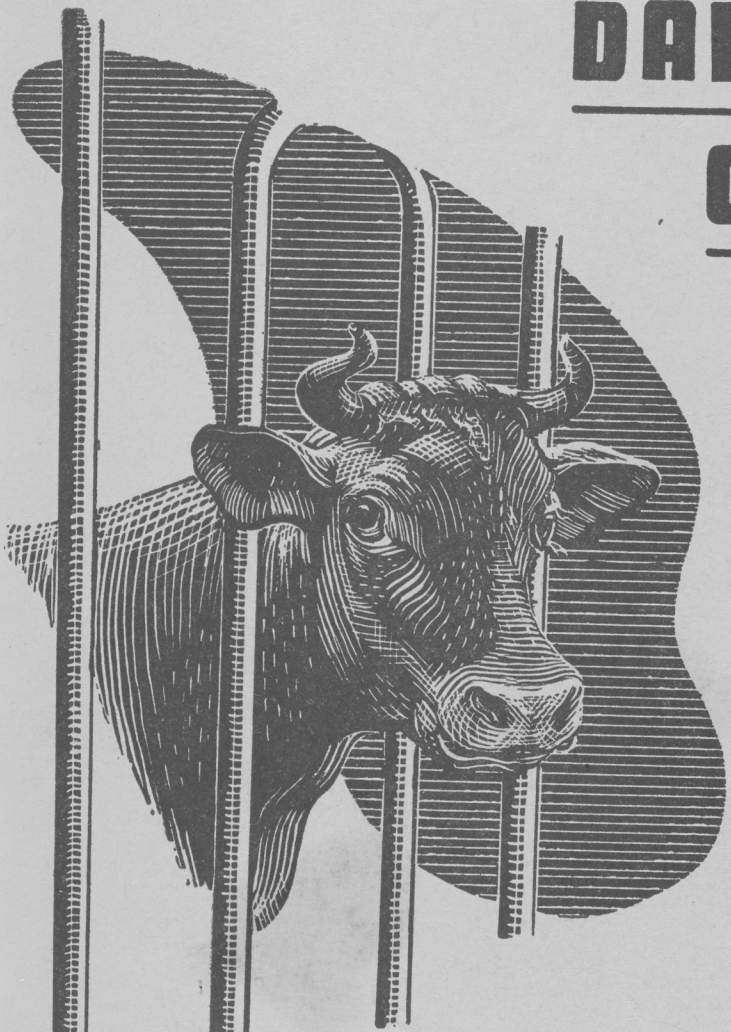

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FEEDING DAIRY COWS

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Feeding Dairy Cows

By Floyd Johnston, Arthur R. Porter and Lyle W. Jackson

DAIRY COWS MARKET FEEDS

Dairy cows furnish a market for the feed produced on the farm and aid in utilizing labor to good advantage. The dairy enterprise must be fitted into the entire farming operation for the best results. On many Iowa farms it is possible to grow the entire dairy ration. Good pasture grass, silage, alfalfa hay, corn, oats and soybeans when fed in sufficient quantities and proper combinations will provide all the nutrients that are necessary. A substantial profit above market value may be realized by using these feeds in the rations for good-producing dairy cows.

Production records on each individual cow will show the difference in cows and the way they respond to different feeding practices. Those records can be used as guides to better feeding methods. But no one can be sure of a cow's producing ability until she has had an opportunity to show it with good feeding and care. The milk scales and the Babcock test will put the blame for low production upon the feeder as well as upon the cow.

The cows with the biggest appetites are generally the best producers if they get enough feed of the right kind. A somewhat fixed amount of feed is needed for maintaining the cow's body, for the unborn calf and for growth. Only the feed consumed above the amount needed for maintenance can be available for milk production. A cow will draw upon her body reserves if her feed does not supply the nutrients needed. She will become thin, and eventually her production will show the effect of an incomplete ration. The more feed a cow eats above maintenance requirements, the more efficient her production will be because a greater percentage of the total feed consumption can go for milk production. The good feeder tries to find the level of feeding where the cow is producing at her economical maximum without injury to herself or without putting on fat. He knows each cow and notes any change in appetite.

In addition to good feeding, *other good management practices are necessary* to obtain the best results from the dairy herd. These practices include keeping the cows comfortable, milking and feeding regularly, avoiding feeds which give undesirable flavors to the milk and cream, protecting the health of the herd and improving the producing ability of the cows by breeding.

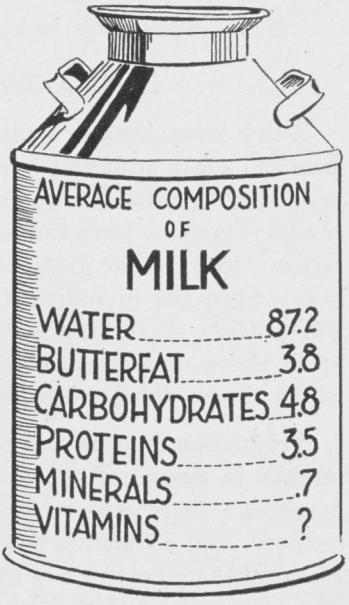

Fig. 1. The raw materials for making milk must be supplied in the cow's feed.

The order of feeding affects production very little if it remains the same. Any necessary changes in feeding order or in feeds should be made gradually. In most cases, feed flavors are imparted to milk only during a few hours after feeding. All feeds likely to give a characteristic flavor to milk should be fed after milking. Pasture feeds that give an undesirable flavor to the milk usually can be used if the cows are removed from the pasture 3 to 5 hours before milking. Cows fed balanced rations may have more resistance to diseases and infections. You can obtain the advantages of inherited high production ability only when good feeding and management bring out that potential ability.

THE NUTRIENTS IN FEEDS

The cow uses feed to maintain her body, furnish energy, provide for growth, develop the unborn calf and produce milk. Those portions of the feeds that are used in the cow's body and for milk production are the nutrients that determine the relative value of different feeds and different combinations of feeds.

The nutrients in feeds which perform specific functions in the cow's body and in milk production are water, carbohydrates, fats, proteins, minerals and vitamins. If any one of these nutrients is

absent or supplied in too small quantities, it will be the one which limits production. A shortage of water, carbohydrates, fats or proteins in the ration will affect the quantity of milk more than its composition.

WATER

Water is one of the most important feeds, usually is one of the cheapest feeds and yet is frequently a limiting factor to high production. Water makes up 70 to 80 percent of the animal body, carries the digested food materials into the body, carries waste products away, helps control body temperature and makes up about 87 percent of milk. Milking cows require more water than any other farm animals.

From 3 to 5 gallons of water are required by a cow for each gallon of milk that she produces. When cows have free access to water, they will drink much more than when watered only twice a day. Fresh water is best. It should be free from ice but is more palatable if not warm. Cows are thirsty after they have eaten dry feed, and water should be available for them. The moisture in feeds serves the same purpose as that from other sources.

CARBOHYDRATES

Carbohydrates make up the largest part of the nutrient material in most feeds. They include sugars, starches and the woody or

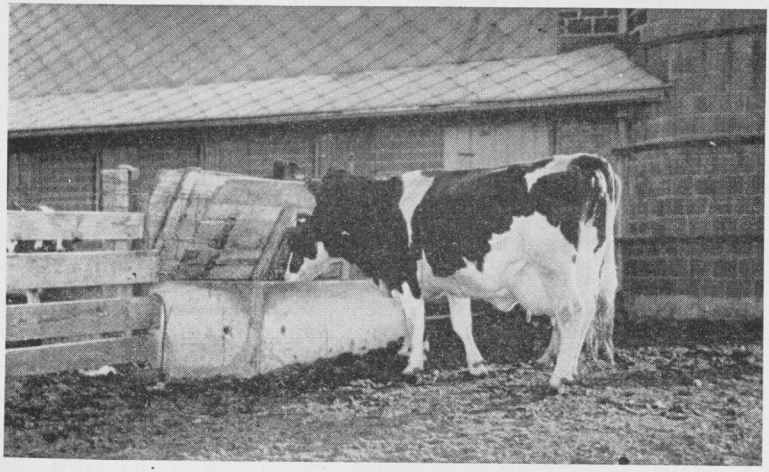

Fig. 2. From 3 to 5 gallons of water are required by a cow for each gallon of milk that she produces.

fibrous portions of feeds. Among Iowa feeds, corn and small grains are the principal sources of carbohydrates in addition to those supplied by roughages. A ration which furnishes the cow enough to eat usually furnishes enough carbohydrates. An excess of carbohydrates in the ration may be stored as fat.

FATS

Fats in the feeds are used much like carbohydrates in the cow's body, but they have an energy value 2¼ times as great as carbohydrates. The cow can build up fats from carbohydrates in her body, but there is some loss of efficiency in doing so. On the other hand, the cow can break down fats in feeds and use them as sugars and starches are used. Fats are sometimes listed by feed manufacturers as "ether extract." Fats are present in all feeds. Fats in ordinary farm-grown feeds are plentiful enough for the dairy cow's ration. Soybeans contain more fat than any other dairy feed commonly used in Iowa.

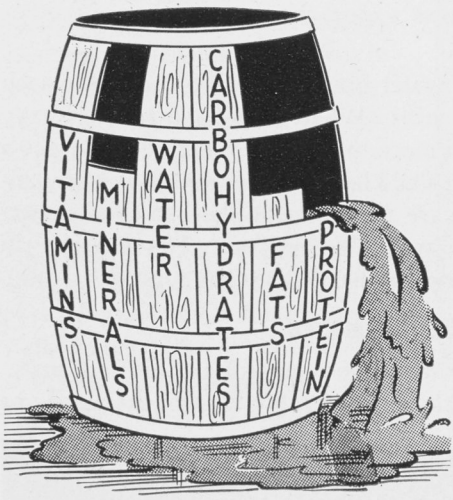

Fig. 3. The cow's total production can be no higher than the lowest stave in the barrel of feed nutrients. If any one is insufficient, it becomes the limiting factor in production.

PROTEINS

Proteins are essential in the cow's feed. The cow cannot make proteins from anything else. Proteins are lacking more often than any other nutrient in Iowa dairy cow rations. Soybean hay or soybeans, alfalfa, clover, lespedeza and other legumes are rich home-grown sources of protein. Soybean oilmeal, linseed oilmeal, cottonseed oilmeal and gluten meal are high protein by-product feeds frequently used to supplement home-grown grains.

Proteins consist of combinations of various amino acids. At least six or seven different amino acids are essential to animals.

However, all feeds contain some proteins and a reasonable variety of feeds in the ration insures an adequate supply of the essential amino acids. As a general rule rations commonly made up of two different roughages and three different grains should furnish sufficient protein variety. If the cow receives more protein than she needs, the nitrogen portion is excreted and the remainder used in a manner similar to that of carbohydrates.

MINERALS

The importance of minerals in the dairy cow ration is often overemphasized. Iowa dairymen waste many dollars every year on unnecessary mineral feeds. Many minerals are toxic or poisonous if fed in large amounts, so it is just as important not to overfeed minerals as it is to feed enough. Never force-feed minerals by the addition of appetizers. Minerals will not replace proteins or other nutrients of the ration.

At least a dozen different minerals are used by the cow, but a good ration with legume hay usually provides enough of all of them except sodium and chlorine. Common salt will furnish these two. Salt is not stored in the body and therefore must be supplied regularly. The best method is to allow free access to it. The needs for salt vary, and the only way to be sure that cows have enough is to allow them to help themselves. One pound of salt to a hundred pounds of grain will supply enough for most cows, but additional salt should be allowed as they choose. Cows should not be forced to eat other minerals in order to get salt. Block salt seldom supplies enough.

Two minerals used in relatively large amounts by cows are *calcium* and *phosphorus*. They make up the largest quantity of the minerals in milk and in the bones. When plenty of legume hay is fed, the calcium needs of the cow usually are supplied. Among the natural feeds roughages provide calcium most abundantly. Roughages will vary in calcium content with the amount of lime in the soil on which they are grown. When legume hay is fed, there is a greater possibility of a lack of phosphorus than a lack of calcium in the ration. The phosphorus content of roughages and grains varies with the available phosphorus content of the soils on which they grow. Soils which give increased yields when phosphate fertilizers are added probably have been raising crops relatively low in phosphorus.

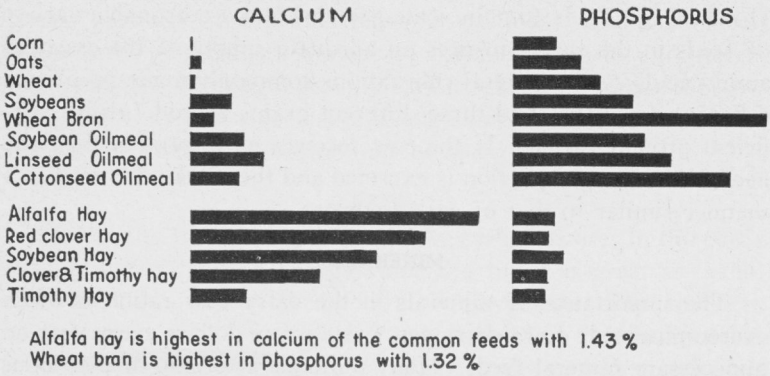

Fig. 4. Calcium and phosphorus content of common feeds. (From Morrison's "Feeds and Feeding," 20th edition.)

These statements suggest the possibility of increasing the intake of calcium and phosphorus for dairy cows by applying lime or phosphates to the pastures and fields on which their feeds are raised. Such a practice will work, but it would not be economical unless the yields are increased enough to pay for the application. If the amount of phosphorus in a ration is low the difficulties from its lack will be aggravated by feeding additional lime or calcium. Dairy cattle seem to use about 1½ to 2 parts of calcium to each part of phosphorus. Those minerals are in about that proportion in steamed bone meal, which is recommended to supplement other feeds if more calcium and phosphorus are needed. Since it is difficult to determine whether or not cows are receiving enough calcium and phosphorus, it may be advisable to allow free access to steamed bone meal from a box in a dry place. If a dairyman wishes to add it to the grain, 2 percent of steamed bone meal in the grain mixture is suggested.

Vitamin D regulates the use of calcium and phosphorus in the body. Dairy cattle secure vitamin D from exposure to the direct rays of the sun and from sun-cured roughages. Calcium and phosphorus usually are stored in the cow's body to a greater extent in the summer than in the winter. Cows build up a reserve of minerals when on pasture and when dry and use them in milk production later. The daily intake and the daily needs seldom balance. Wheat bran and cottonseed meal are good sources of phosphorus.

If phosphorus supplements from phosphate rock are used, make sure that fluorine is not present in excess. To be safe for dairy

cattle feeding, defluorinated phosphates should contain not more than .1 percent of fluorine.

Only a few cases of *iodine* deficiency have been reported in Iowa. The lack of iodine is probably the most common cause of goiter in calves. Unless some evidence of "big neck" has been seen, it is doubtful if iodine should be added to the ration. If a deficiency is suspected, iodine can be supplied easily in the form of iodized salt in the same manner recommended for ordinary salt. Iodized salt which is guaranteed to contain at least 0.015 percent of iodine is sold by many Iowa dealers. Iodine in block salt oxidizes from the surface so that much of it is wasted. The feeding of iodine has been found to increase the iodine content of the milk. It is doubtful, however, if milk production is stimulated to any extent by its addition to the ration.

Other minerals such as iron, copper, potassium, magnesium and manganese usually are supplied in sufficient quantities in the ration without supplementary feeding.

VITAMINS

Vitamins are feed constituents which are essential for life and for normal body functions. Compared to other nutrients, they occur in feeds in relatively small quantities but nevertheless are extremely important. Many vitamins have been discovered, but not all of them are needed in feeds for cows. Vitamins A and D seem to be ones of the greatest importance and could be lacking in some inferior rations.

Vitamin A is necessary for growth and the maintenance of health. Its lack causes eye weaknesses. Calves fed for a long time on rations extremely low in vitamin A have become blind. The resistance of calves fed for extended periods of time on rations very deficient in vitamin A is so greatly lowered that secondary complications such as scours and pneumonia often develop. A severe lack of vitamin A for months may cause impairment of the nervous system, poor muscular coordination, shy breeding, abortions and weak calves. These last indications of nutritional deficiencies seldom occur and then not under normal feeding conditions. Vitamin A is spoken of as the anti-infection vitamin because its presence is thought to build resistance to infections.

Cows get pro-vitamin A from many feeds containing a yellowish colored substance called *carotene*. Carotene is found in green

plants but is destroyed by long exposure to the sun in curing. The best natural sources of carotene among cattle feeds are succulent green grasses, new-mown, green and leafy hay, ensilage, green fodders and yellow corn. The pro-vitamin A value of other grains is too low to be important in the ration. Cows use a great deal of roughage and, therefore, may obtain sufficient vitamin A if the roughage is of good quality. The amount of vitamin A in the milk they produce is governed by the amount in the rations they eat. Milk is nearly always higher in vitamin A value during the season when cows are on pasture than it is in the wintertime. Green roughages are important for the vitamin A nutrition of the cow herself, her calf or any other animal nourished by her milk. The vitamin A or carotene goes along with the butterfat so that it is present in whole milk, cream and butter but to a lesser degree in skimmed milk.

Vitamin D is necessary so that the cow may use calcium and phosphorus most efficiently. Vitamin D is also needed for the development of bones and teeth. Growing animals on rations deficient in vitamin D develop rickets, characterized by swollen joints, arched backs, bent knees, stiffness and poor appetites. In the summertime cows secure plenty of vitamin D from exposure to sunlight. In the wintertime, sun-cured hays and fodders are sources of vitamin D. Many fish liver oils are rich in vitamins A and D but seem to be somewhat toxic to cows and are not recommended for milking cows. Irradiated yeast is sometimes fed to increase the vitamin D content of the milk produced; but no improvement has been noticed in the health or production of the cows so fed.

Vitamin E has been given much publicity. There are no experimental data that prove that supplementary feeding of vitamin E is needed by cattle. It has been shown that goats do not need vitamin E in their feed. If cattle do need vitamin E they probably get plenty in their ordinary rations. All common feeds contain vitamin E, particularly the germ portion of seeds such as corn, soybeans, oats, barley and wheat.

The vitamins of the B complex are formed by bacterial action in the cow's paunch. Additional amounts in their feed have not been advantageous.

ROUGHAGES — THE BASIS OF DAIRY CATTLE FEEDING

The dairy cow is particularly adapted to using roughages and converting them into food for man. If grown at home, roughages usually are the cheapest source of nutrients for cows. Being bulky, roughages are relatively expensive to transport and cannot be moved far without adding greatly to their cost. With good legume hay, silage and pasture, the dairy feeding problem is relatively simple.

PASTURES

Luxuriant **pasture** is ideal in the dairy ration. It is palatable, bulky, succulent and has approximately the balance of nutrients required by the cow. Pastures, when properly managed, can supply cheap feed for cows. The cost of feeding a cow in the barn is approximately two or three times as much as the cost of feeding her when she is on good pasture. Young, rapidly growing grasses are similar in their composition but differ tremendously in the amount of nutrients produced per acre. Mixtures of grasses and legumes yield better and are relished more by cows than a single grass or legume crop.

Cornstalks make extremely poor pasture for milking cows, even when supplemented by a good grain mixture. At first the cows get too much corn and later nothing but stalks. The stalks are high in fiber and low in nutritive value. Young cattle can utilize stalk pastures if they have protection from bad weather and do not have to depend upon stalks for the entire ration.

The pasture season can be lengthened by using supplementary crops that are ready to graze when the permanent pastures are short. **Rye,** seeded in the fall, makes a temporary fall and early spring pasture. Care should be used to avoid undesirable flavors in the milk from rye pasture. Removing the cows from pasture at least 3 hours before milking will help overcome this difficulty. **Oats** are the best pasture crop for early spring seeding. Used as a nurse crop, oats can be pastured with no harm to the new seeding if the stock is kept off after rains and if the oats are not grazed too closely.

Sudan grass, seeded the middle of May to the middle of June, makes an ideal summer pasture. The carrying capacity of this crop is high. It grows the best in extremely hot midsummer weath-

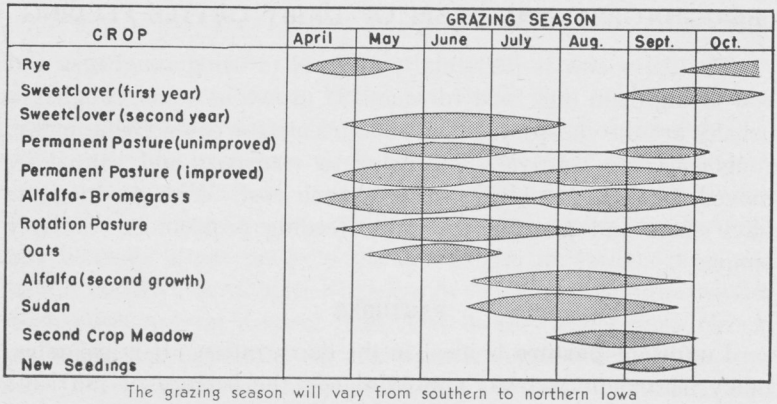

Fig. 5. Pasture calendar.

er when bluegrass makes very little growth. To avoid any possible danger from prussic acid poisoning, sudan grass should not be pastured until it is 18 inches high. This practice also favors high production per acre. New growth that comes after a freeze should not be pastured, as there is a danger of prussic acid poisoning.

Sweetclover, sown with the small grain, makes a good late pasture and carries over for the next year. **Alfalfa** can be pastured, but dairymen favor alfalfa with some timothy or bromegrass mixed with it. The alfalfa-bromegrass or timothy mixture will give less trouble from bloat and higher yields than alfalfa alone.

Bromegrass is drouth- and heat-resistant, productive and palatable. It starts growth early in the spring and stands up under heavy grazing. Bromegrass does best when seeded with legumes in a long rotation.

Reed canarygrass is especially adapted to wet soils which are subject to overflow for periods that would kill other grasses.

The chief difficulty with pastures is the seasonal gaps in their growth. The pasture calendar gives the approximate grazing periods for various pastures.

HAY

Hays vary considerably in feeding value, depending upon kind, stage of maturity when cut and the method of curing. In general, early-cut hay which retains its leaves and its green color is far

superior to bleached, stemmy or late-cut hay, regardless of its variety. Legume hays contain more protein than grass hays and, therefore, are more desirable for dairy cows.

The largest yields of high-grade hay are obtained from alfalfa if it is cut when one-tenth to one-half in bloom. At that stage about half the total weight and three-fourths of the protein is in the leaves. A loss of leaves means a reduction in the protein content of the remaining hay. Alfalfa leaves have about two and one half times as much protein as the stems. The protein in the leaves is more readily digestible than in the stems. Haying methods that save leaves help to retain far more food nutrients than the saving in weight would indicate.

Red clover gives the greatest yields and most protein per acre if cut when about 50 percent in bloom. Timothy and other grass hays are higher in protein and more palatable if cut early. It is impossible to overemphasize the importance of cutting hay early and curing and handling it carefully to prevent the loss of leaves. Methods that save leaves also save the green color and its accompanying pro-vitamin A.

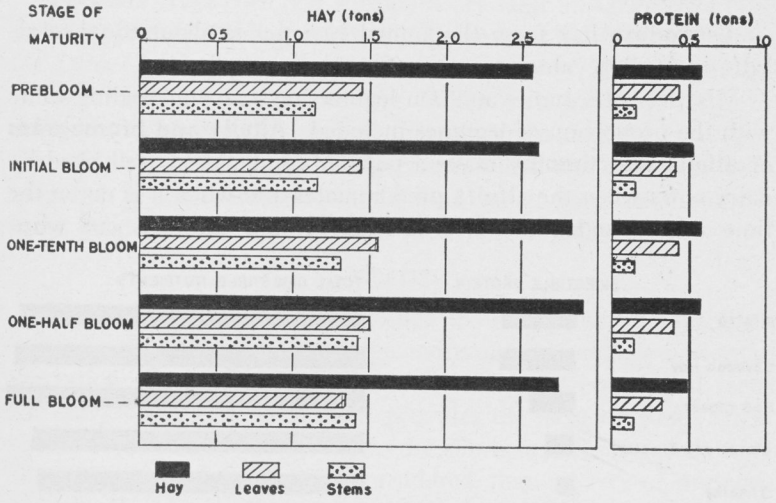

Fig. 6. The yield of hay and the yield of protein per acre are influenced by the stage of maturity at which alfalfa is cut.

The largest yields of high-grade hay are obtained if alfalfa is cut when one-tenth to one-half in bloom. The yield of protein per acre shows little variation during the prebloom, initial-bloom, one-tenth bloom and half-bloom stages. At the half-bloom stage of growth of alfalfa about half of the total hay consists of leaves, but they contribute approximately three-fourths of the total protein.

Legume hays such as alfalfa, soybeans, clover and lespedeza are always relatively rich in protein and minerals. They are excellent for milk production. **Alfalfa** ranks at the top of the list, being more palatable, easier to cure and higher yielding in total nutrients and protein per acre. It contains more than three times as much protein as timothy and contains more calcium than any other of the common feeds.

Soybean hay is practically equal to alfalfa in protein. Soybeans make a good emergency hay crop. Soybeans, however, are an annual crop and are harder to cure than some other hays.

Red clover is similar to alfalfa but somewhat less palatable and is lower in protein.

Sweetclover has about the same feeding value as the other clovers but is often coarse and stemmy and therefore more difficult to cure. Normal clotting of the blood has failed in many cases following the feeding of sweetclover hay. Animals fed sweetclover hay have been known to bleed to death when dehorned, castrated or injured. It is advisable to feed some other hay with sweetclover to reduce this danger. Sweetclover is a better pasture than hay crop.

Lespedeza hay from the annual varieties is about equal to alfalfa in feeding value.

Mixtures of legumes and non-legume hays vary in feeding value with the proportion of legumes included. **Alfalfa and bromegrass** or **alfalfa and timothy** make a popular combination well liked by dairy cows when the alfalfa predominates and when it is cut at the time recommended for alfalfa. **Clover and timothy,** cut when

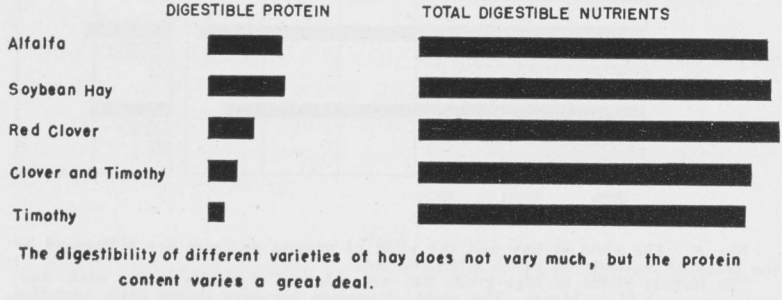

Fig. 7. Comparison of different hays in digestible protein and total digestible nutrients.

about half the clover is in bloom, ranks well above the non-legume roughages.

Timothy, prairie grass, sudan grass, millet and oat hays are non-legume roughages relatively low in protein and minerals. For this reason they rate low as dairy cow feeds.

Grinding hay or fodder does not increase its digestibility. Grinding makes it impossible for the cow to sort out and leave the coarsest, least desirable portions. For that reason she is forced to eat more high-fiber, low-digestible material than if it were fed unground. Numerous experiments have shown that grinding of hay for dairy cows is not profitable. Unless roughage is scarce and high priced and grinding costs are unusually low, grinding is a questionable practice with fodder. Finely ground roughage may cause impaction when fed to cattle.

Chopped hay or fodder has about the same feeding value as unchopped. The advisability of chopping hay depends upon the amount of mow space available. When hay is chopped, much more can be stored in a limited amount of space. The desirability of chopping fodder depends upon the equipment on hand, labor and the supply of roughage.

Fodders from corn and sorghums are high in indigestible fiber and the waste in feeding is great. The greatest waste occurs while the fodder is curing in the field, where losses of 30 to 40 percent in food value are not uncommon. When corn fodder is fed, it is difficult to regulate the amount of corn grain that the cow gets. Corn stover, which is the fodder from which the ears have been removed, is considerably lower in food value. Sorghum fodder is more palatable than corn fodder but is less valuable as a feed.

SILAGE

Silage is a succulent feed. When fed in addition to hay, silage increases the cow's total roughage consumption and adds variety to the ration. **Corn silage** may be one of the most economical feeds for dairy cows. The corn plant provides the most nutrients when ensiled. An acre of corn put into the silo is invariably worth more for milk production, all costs considered, than an acre of dry corn fodder. **Sorghum silage** ranks slightly below corn silage as a dairy feed. Because it usually contains more moisture, it is less valuable per pound than corn silage. Little difference in feeding value has been found between silages made from the different vari-

eties of sorghum. **Sweet corn cannery silage** from husks and cobs has about two-thirds the digestible nutrients of ordinary corn silage.

Any crop that can be made into hay can be made into silage. The protein content of **legume silage** is higher than corn or sorghum silage, but the energy value is less. It is desirable to add corn-and-cob meal, ground shelled corn, molasses or dilute acids to legume crops as they are being ensiled to act as preservatives.

Roots and **tubers** are similar in feeding value to silage but are more expensive to grow and harvest. They should be chopped or sliced before feeding to avoid the possibility of choking the cow. **Beet pulp** is a palatable and laxative feed but is limited in its use by cost.

GRAINS FOR DAIRY COWS

High producing dairy cows cannot eat enough roughage to get all the nutrients they need, and some of the nutrients must be supplied in a more concentrated form. Grains ordinarily are 25 to 30 percent higher in total digestible nutrients than roughages. The common grains grown on Iowa farms are excellent sources of carbohydrates. If soybeans are raised to furnish additional protein, the entire ration can be home-grown.

HOME-GROWN GRAINS

Corn is palatable, highly nutritious and usually supplies nutrients cheaper than any other common grains. For this reason corn should comprise a large proportion of the concentrates fed. Corn-and-cob meal contains approximately 90 percent of the nutrients of ground shelled corn. Grinding ear corn generally is cheaper than shelling the corn and then grinding it.

Oats are excellent for cow feed. Slightly lower in digestiblity but higher in protein than corn, they are bulky, palatable and serve well in grain mixtures.

Wheat is well liked by dairy cattle, but because of its gluten content it may become pasty when eaten unless mixed with other feeds. Wheat and corn are similar in total digestible nutrients for dairy cows, but wheat contains more protein.

Barley is a good substitute for corn, having nearly the same feeding value and effect upon the cow.

Rye is less desirable than other grains and is rather unpala-

table. It should not make up more than one-fourth of the grain fed.

Soybeans as a source of protein are equal to linseed oilmeal and other high-protein feeds when cracked and fed to dairy cows. The oil in soybeans can be used by milking cows without difficulty. Experiments have shown no ill effect upon the cow from using cracked soybeans liberally in her ration with good quality roughage.

All home-grown grains should be ground before feeding. A saving of 10 to 25 percent can be made by grinding grain. Fine grinding is not necessary. Medium to coarse grinding is cheaper and ordinarily makes a more palatable feed. During the process of grinding and shoveling the feed from the grinder to the storage bin, a mixture of different ingredients can be made with little additional labor.

BY-PRODUCT FEEDS

Various commercial by-product feeds are regularly available on the market and can supplement or replace home-grown grains for feeding dairy cows. **Wheat bran** is one of the best by-product feeds for dairy cows. It is bulky in character, laxative and contains more phosphorus than whole grains. Wheat bran is somewhat similar to oats in feeding value and can readily be substituted for oats.

Soybean oilmeal is the residue after oil is extracted from soybeans. It is an excellent source of additional protein for the dairy ration.

Linseed oilmeal is the product left when oil is extracted from the flax seed. It is an old standby for dairymen and is well liked as a means of adding protein to carbohydrate feeds.

Cottonseed meal is high in protein and can be used the same as other high-protein feeds with home-grown grains.

Corn gluten meal is a by-product of the industrial utilization of corn for starch and glucose manufacture. It ranks high in protein and can be used to mix with low-protein feeds.

Corn gluten feed should not be confused with corn gluten meal because it has about half as much protein. It can be used in the dairy ration if its price justifies it.

Distillers' grains are by-products of the manufacture of alcohol from corn, rye and other grains. They vary greatly in protein con-

tent. They are bulky but rather unpalatable, and if fed should be mixed with other grains. They are best when fed dry.

Malt sprouts are the shriveled sprouts which have been separated from the dried malt grains and have about 20 percent digestible protein. They are not palatable but may be mixed in limited amounts with other feeds. Large amounts may produce a noticeable flavor in the milk. They swell when absorbing water. If more than 2 pounds daily are fed, they should be soaked first.

Molasses is useful as an appetizer and frequently is used to make unpalatable feeds more readily consumed. It is used extensively in commercial mixed feeds for that purpose. Molasses is a carbohydrate feed. The relatively low total digestible nutrients in molasses may make it high priced for regular feeding.

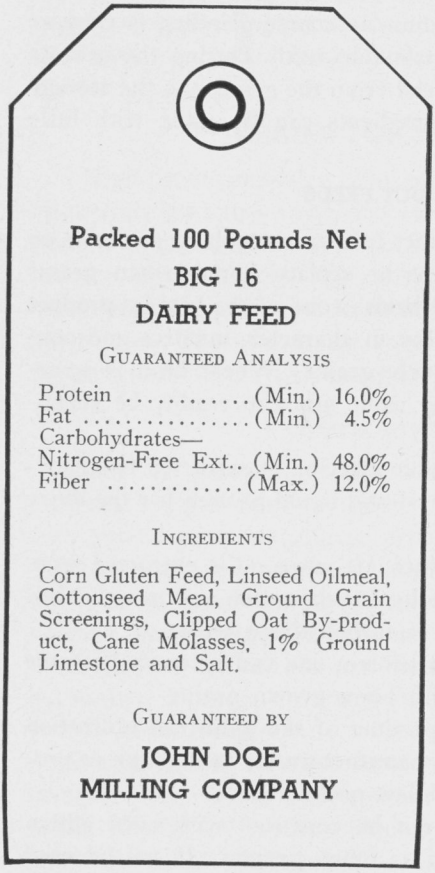

Fig. 8. An example of a feed tag which is attached to the sack. Note the protein content, the percentage of fiber and the list of ingredients. Low-protein commercial mixed feeds may contain much filler such as oat hulls, mill sweepings and screenings.

Oat feed is a by-product from oats, mostly from oatmeal factories, and consists of oat shorts and hulls. The feed usually contains 5 to 6 percent protein and 27 to 30 percent fiber. Approximately 80 percent of it is oat hulls, which are about equal to oat straw in feed value.

PREPARED DAIRY FEEDS

Of the many prepared dairy feed mixtures sold in Iowa, some are good and others are inferior in quality. If all or nearly all of the concentrate portion of the ration is purchased, ready-mixed feeds should be considered.

Ready-mixed feeds have more advantages for the small herd owner than for one feeding a large quantity of grain. The cost of ready-mixed feeds should be compared with the cost of buying supplementary feeds and mixing with home-grown grains at the mill or at home.

The dairyman who has corn and oats, or barley and oats, needs only a high-protein feed to make a balanced grain mixture. Usually the protein can be obtained most cheaply in the form of cracked soybeans, soybean oilmeal, linseed oilmeal, cottonseed meal or corn gluten meal. Compare the cost of a pound of digestible protein in selecting any feed or feed mixture to be purchased.

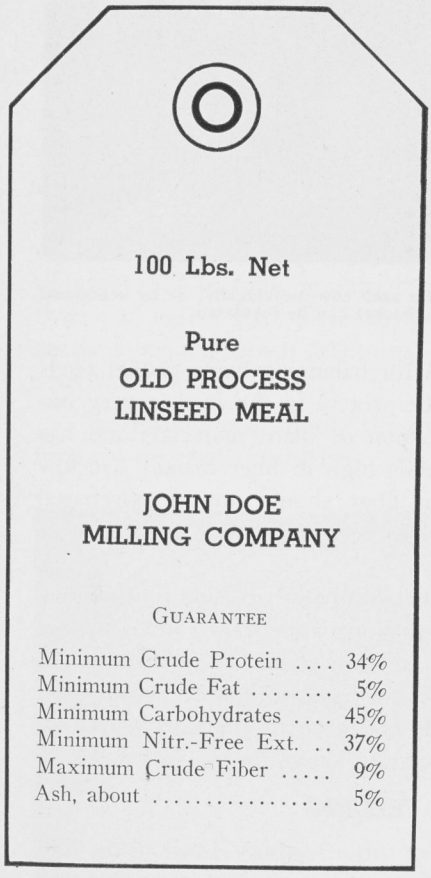

Fig. 9. An example of a tag from a linseed meal sack. Instead of tagging, many mills stamp the same information on the sack. It is important to remember that the analyses as given are the total, not the digestible nutrients.

Iowa has laws governing the sale of commercial feeds, mineral mixtures and stock tonics. These laws protect the purchaser by requiring the feed manufacturer to state how much of each principal nutrient is contained in the feed. The ingredients of a mixture must be named, but the percentage of each is not required. The figure on the tag or the sack are in terms of the total crude material. About 75 to 85 percent of the total nutrients of commercial feed mixtures are digestible.

The analysis on the tag or sack should be read carefully before a purchase is made. Particular attention should be given to the percentage of protein and fiber. Commercial

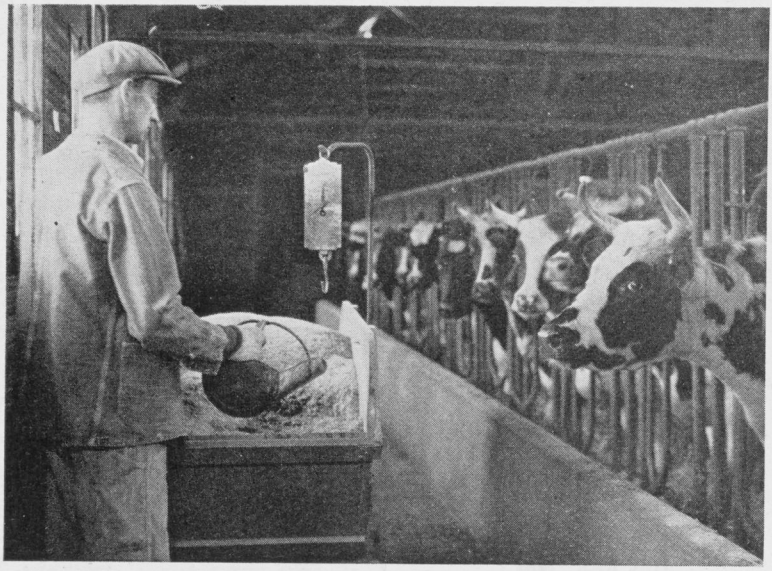

Fig. 10. The feed may be weighed for each cow individually; or by occasional weighing, the amount in a hand scoop or bucket can be regulated.

feedstuffs usually are purchased for balancing home-grown feeds so that the cost per pound of the protein in the feed is very important. Fiber is the woody portion of plant materials and has little feed value to the cow. Feeds high in fiber usually are low in digestibility. A feed high in fiber should not be purchased until the cost of its nutrients has been compared with that of others available.

Many so-called "tonics" or "conditioners" are sold on the market. It generally is claimed that they are appetizers and regulators and that they supply vitamins and minerals. They usually are harmless if not fed excessively. They have little effect on the cow. Under normal conditions, cows do not need stimulants. If cows are sick or out of condition, a veterinarian should be consulted.

WINTER FEEDING

Roughage is the basis of dairy cattle feeding. Feed all the **hay** the cow will clean up readily. If no silage is fed, this amount will be 2 to 3 pounds daily for each 100 pounds liveweight. If silage is fed, the average cow will consume 1 to 2 pounds of hay daily for each 100 pounds that she weighs.

Feed **silage** liberally. Cows will consume about 3 pounds daily for each 100 pounds of liveweight in addition to hay. If silage is plentiful and the supply of hay is limited, the silage can be increased materially. In experimental trials cows receiving no hay have eaten up to 90 pounds of silage per day. Although this extreme is not recommended, it shows that silage can replace all of the hay in the ration.

Feed **grain** according to the production of the individual cow. You may use as a guide the general rule of 1 pound of grain for each 3 to 5 pounds of milk produced by Ayrshires, Brown Swiss, Holsteins or Milking Shorthorns, and 1 pound of grain for each 2½ to 3½ pounds of milk for Guernseys and Jerseys. These proportions will have to be varied to fit the individual case, the relative value of milk or butterfat and the cost of grain. Higher rates of grain feeding are needed with low quality roughage. Cows milking up to 15 pounds of milk daily can obtain all or nearly all of their feed needs from good roughage. Therefore, the proportion of grain fed to milk produced can be lower for low producing cows and higher with increased production. Eventually a point is reached beyond which additional grain feeding might not be advisable.

The grain must supply the nutrients the roughages lack. A mixture of grains ordinarily will be more palatable than a single

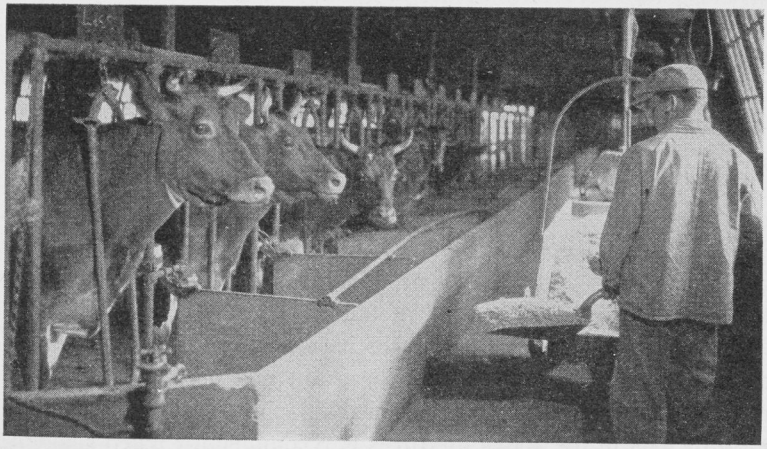

Fig. 11. Guessing at the amount fed from a basket or scoop shovel cheats some cows and overfeeds others.

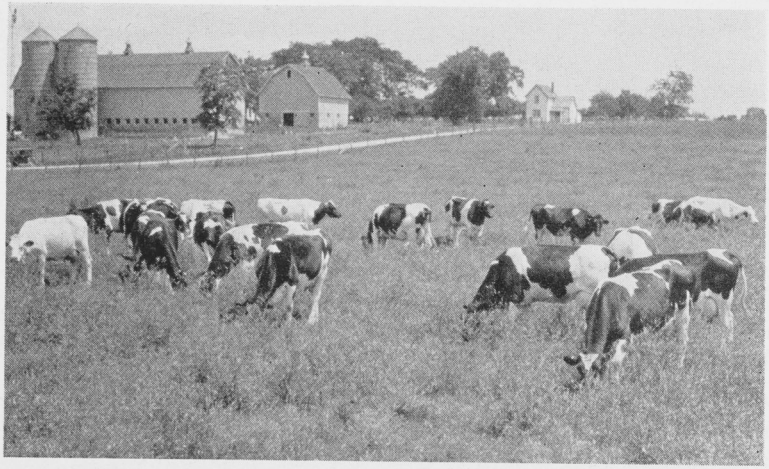

Fig. 12. Luxuriant pasture is ideal in the dairy ration.

grain. With low quality roughage, and also with high producing cows, mixtures of grains have an advantage. Usually three grains will provide plenty of variety.

When deciding upon the grain mixture to make:

1. Vary the protein content to balance the kind of roughage with which it will be fed.
2. Use feeds which supply the digestible protein and total digestible nutrients most cheaply.
3. Supplement home-grown feeds when necessary with purchased feeds.
4. Make a mixture which is palatable and which contains no substance injurious to cows.
5. If roughage is limited the grain mixture should be bulky.
6. Calculate the cost per ton in order to compare it with other mixtures.

With good legume roughages the grain mixture can be very simple. It need contain high-protein feeds only when it is fed to cows producing over a pound of butterfat a day each.

When silage is fed, 3 pounds of it will replace 1 pound of hay; additional protein is needed in the grain mixture. Fifty pounds more of high-protein feed replacing 50 pounds of corn-and-cob meal or oats in the above mixtures is recommended when silage is fed.

With legume roughages approximately 1 pound of high-protein supplement to each 9 pounds of farm grains is suggested. With a mixture of legume and non-legume roughages approximately 2 pounds of high-protein feed to each 8 pounds of farm grains is needed. With non-legume roughages 3 to 3½ pounds of high-protein feed will be needed to make up the mixture of 10 pounds when the rest of the feed is farm grains.

If these feeds are not on hand or others can be purchased more cheaply, any of the following *substitutions* can be made with satisfactory results.

TABLE 1. SUGGESTED GRAIN MIXTURE TO FEED WITH HIGH-PROTEIN ROUGHAGES

(Such as alfalfa, soybean or clover hay, without silage)

Total protein ..... 12-14 percent
Digestible protein ..... 9-12 percent

	Mix. 1 (lbs.)	Mix. 2 (lbs.)	Mix. 3 (lbs.)	Mix. 4 (lbs.)	Mix. 5 (lbs.)
Corn-and-cob meal	600	500	600	500	400
Ground oats	300	400	100	200	300
Wheat bran	...	...	200	200	200
High-protein feed*	100	100	100	100	100

TABLE 2. SUGGESTED GRAIN MIXTURES TO FEED WITH MIXED HAY

(Such as clover and timothy, or both high- and low-protein roughages without silage)

Total protein ..... 14-16 percent
Digestible protein ..... 12-14 percent

	Mix. 1 (lbs.)	Mix. 2 (lbs.)	Mix. 3 (lbs.)	Mix. 4 (lbs.)	Mix. 5 (lbs.)
Corn-and-cob meal	600	500	500	500	400
Ground oats	200	300	100	200	200
Wheat bran	...	...	200	100	200
High-protein feed*	200	200	200	200	200

TABLE 3. SUGGESTED GRAIN MIXTURES TO FEED WITH LOW-PROTEIN ROUGHAGES

(Such as timothy, bromegrass, sudan grass, oat hay, corn or sorghum fodder without silage)

Total protein ..... 18-20 percent
Digestible protein ..... 16-18 percent

	Mix. 1 (lbs.)	Mix. 2 (lbs.)	Mix. 3 (lbs.)	Mix. 4 (lbs.)	Mix. 5 (lbs.)
Corn-and-cob meal	500	400	400	400	300
Ground oats	200	300	100	200	200
Wheat bran	....	....	200	100	200
High-protein feed*	300	300	300	300	300

*High-protein feeds to use may be cracked soybeans, soybean oilmeal, linseed oilmeal, cottonseed meal or corn gluten meal. Recent experiments indicate that with roughages of poor quality, not leafy and lacking good green color, soybean feeding should be limited.

1. Corn-and-cob meal can be replaced by an equal weight of ground shelled corn or barley. Ground wheat can be substituted for corn.

2. Ground oats can be replaced by an equal weight of bran, but due to the lower total digestible nutrients in bran it would be desirable to increase the percentage of corn in the grain mixture.

3. About two-thirds of a pound of tankage will replace the protein in 1 pound of soybeans. A man with dairy cows and good quality roughage cannot afford to raise soybeans and sell all of them for processing unless soybean oilmeal or other high-protein feed be can purchased at a price enough below soybean prices to merit the substitution.

To calculate percentage of digestible protein in a mixture:

1. Multiply the percent of digestible protein in each grain (see table 10, page 984) by the number of pounds of that grain in the mixture.

2. Add the results.

3. Divide the sum by the total pounds of the mixture.

4. Multiply the result by 100, which will give the percent of digestible protein.

Example:	Lbs.		Percent digestible protein		Digestible protein (lbs.)
Corn-and-cob meal	600	x	6.0	=	36.0
Ground oats	300	x	9.4	=	28.2
Cracked soybeans	100	x	32.8	=	32.8
	1000				97.0

97 ÷ 1000 = .097

.097 x 100 = 9.7 percent digestible protein.

SUMMER FEEDING

Pastures are the basis of summer feeding for dairy cows in Iowa. With abundant grasses the summer feeding problem is simple. Grazing should not begin in the spring until the grass is long enough for the cows to get a good mouthful. Changes from winter to summer feeding should be made gradually to accustom the cow's digestive system to the new feed and to avoid "grassy" flavors in the milk. The early grass is "washy" and it is advisable to continue the feeding of grain for 10 days or 2 weeks. After that time,

TABLE 4. SUGGESTED GRAIN MIXTURES TO SUPPLEMENT GOOD PASTURES*

Total protein ..... 10-14 percent
Digestible protein ..... 8-11 percent

	Mix. 1 (lbs.)	Mix. 2 (lbs.)	Mix. 3 (lbs.)	Mix. 4 (lbs.)	Mix. 5 (lbs.)
Corn-and-cob meal	500	500	400	...	400
Ground oats	450	...	300	500	300
Ground barley	...	...	...	500	...
Ground wheat	...	500	...	...	300
Wheat bran	...	...	300	...	..
Cracked soybeans	50	...	...	...	...

*See page 974 for other substitutions.

grain feeding should be adjusted to the production of the cow and the condition of the pasture.

High producing cows need grain, because it is impossible for them to eat enough grass to meet their needs. On luxuriant pasture cows producing less than a pound of fat a day do not need grain.

For cows producing a pound or more of fat a day, feed 1 pound of grain to each 5 to 7 pounds of milk produced daily. These amounts should be increased when pastures become dry. As pasture grasses mature, they are lower in protein content than when growing rapidly, and more protein is needed from other sources.

Silage is valuable to supplement late summer pastures. Hay can also be used when pastures are short. Soiling crops, such as green alfalfa, soybeans or corn, are valuable supplements to pasture but require more labor than grain or hay.

FEEDING THE DRY AND THE FRESH COW

High condition at calving time is desirable if a cow is to be a high and profitable producer during the ensuing lactation. When a cow starts milking, the extra condition soon disappears. The good cow produces during the first month or two of lactation at a higher level than can be sustained by the feed she eats. It is doubtful whether a cow can become overfat during a dry period of 2 months or less.

Liberal feeding of good roughage is just as important for the dry cow as for the milking cow. The same ration that she was getting when in milk can be used during most of the dry period. The amount of grain to feed depends upon the size, the condition of the cow and the length of the dry period.

A week or 10 days before freshening, the grain should be reduced to between 4 and 8 pounds daily and the mixture changed to include more oats and bran and less corn. A good grain mixture to feed at that time is:

Ground oats	5 parts
Wheat bran	4 parts
Cracked soybeans	1 part

Dried beet pulp is an excellent feed to use before and after freshening. One hundred pounds of dried beet pulp can be added to the grain mixture suggested. Plenty of water and moderate exercise are important.

As soon as possible after calving, give the cow all the lukewarm water she wants to drink. For a day or two after freshening, her feed can be some legume hay, a limited amount of silage, and a mash made from wheat bran, a little linseed oilmeal, some salt and enough water to moisten it. Both before and after calving, it is extremely important that feeds be bulky and laxative. If a cow wants to drink some of her colostrum milk from a clean bucket, let her have it.

Three or four weeks after calving should be taken to get a fresh cow up to full grain feed. More time should be taken for heavy milkers. Begin with 4 to 6 pounds of grain daily and increase at the rate of an extra pound every third or fourth day until she is getting the desired amount in proportion to her production. During at least 2 weeks after freshening, the grain mixture should include more oats and bran than normal. The mixture fed before freshening can be continued for the first few weeks after freshening and gradually changed to the regular herd mixture.

THE USE OF FEEDING STANDARDS

Practical feeding does not require the calculation of individual rations for each cow in the herd. The suggestions for feeding given on page 971 and the grain mixtures suggested for various roughages on page 973 provide rations that are sufficiently well balanced. It is of value, however, to select a typical animal in the herd and balance a ration for her.

In balancing a ration it is first necessary to know the amounts of the various nutrients required. From much experimental and practical feeding work, the requirements for body maintenance and

TABLE 5. DAILY REQUIREMENTS OF DAIRY COWS
(Adapted from the Morrison Feeding Standard)

	Digestible protein (lbs.)	Total digestible nutrients (lbs.)
For body maintenance of a 1,000-lb. cow	.650	7.930
To allowance for maintenance add:		
For each lb. of 3.0 percent milk	.043	.276
For each lb. of 3.5 percent milk	.046	.300
For each lb. of 4.0 percent milk	.049	.324
For each lb. of 4.5 percent milk	.052	.349
For each lb. of 5.0 percent milk	.056	.373
For each lb. of 5.5 percent milk	.059	.397
For each lb. of 6.0 percent milk	.062	.422
For each lb. of 6.5 percent milk	.065	.446
For each lb. of 7.0 percent milk	.068	.470

milk production of dairy cows have been determined. As a result, it is possible to calculate with reasonable accuracy the requirements of any cow. By making use of the information given on page 984 (table 10) regarding the digestible nutrients of feeds you can prepare a ration that will supply the nutrients needed.

Cows use feed for maintenance of their bodies and for producing milk. Table 5 shows the daily requirements for maintenance of a 1,000-pound cow and for given weights of milk containing various percentages of butterfat.

TO FIND THE TOTAL REQUIREMENTS

First estimate the weight of the cow and then compute the requirements for maintaining a cow of that weight. Then calculate the requirements for her milk production and add these requirements together. For example, take a 1,100-pound cow producing 30 pounds of 4 percent milk daily.

	Digestible protein (lbs.)	Total digestible nutrients (lbs.)
For maintenance (1.1 x .650 and 7.930)	.715	8.723
For production (30 x .049 and .324)	1.470	9.720
Total requirements	2.185	18.443

TO BALANCE THE RATION

Having found the total requirements of the cow, the next step is to select a ration which will supply these requirements and at

the same time be economical and practical. Assume that the feeds available are alfalfa hay, corn silage, corn, oats and soybeans. For the composition of these feeds, use table 10, page 984.

Referring to the suggestions for feeding as given on page 970, we find cows should consume 1 pound of hay and 3 pounds of silage for each 100 pounds of the cow's weight, which for a 1,100-pound cow gives the following:

	Digestible protein (lbs.)	Total digestible nutrients (lbs.)
11 pounds alfalfa (.11 x 10.6 and 50.3)	1.166	5.533
33 pounds corn silage (.33 x 1.3 and 18.7)	.429	6.171
Total supplied by the roughage	1.595	11.704

To supply the additional nutrients necessary to meet the total requirements the next step is to add what would appear to be a reasonable feed of grain (8 pounds). As a guide we use the suggestion of feeding grain given on page 971 and a mixture suggested to be fed with alfalfa as given on page 973.

	Digestible protein (lbs.)	Total digestible nutrients (lbs.)
600 lbs. corn-and-cob meal (6 x 6.0 and 75.9)	36.0	455.4
300 lbs. ground oats (3 x 9.4 and 71.5)	28.2	214.5
100 lbs. cracked soybeans 1 x 32.8 and 86.2)	32.8	86.2
1,000 lbs. Total	97.0	756.1
Dividing the totals by 1,000 gives the amount supplied by each pound	097	.756
8 lbs. grain (8 x .097 and .756)	.776	6.048
Supplied by roughage	1.595	11.704
Total supplied	2.371	17.752
Required	2.185	18.443
Difference	+ .186	— .691

For all practical purposes this supply is close enough to the requirements to be entirely satisfactory. If the amount of digestible protein supplied is within .3 pound of that required and if the total digestible nutrients are within 1 pound of that required, the ration is considered satisfactory.

If the roughage is good enough so that greater consumption can be obtained than the figures used here, the grain can be adjusted accordingly.

TABLE 6. STANDARD WEIGHTS OF COMMON FEEDS

	Pounds per bushel	Pounds per quart unground	Number bushels per ton
Barley	48	1.01	41.7
Corn (shelled)	56	1.75	35.7
Corn (ear)	70	1.50	28.5
Oats	32	1.03	62.5
Rye	56	1.85	35.7
Soybeans	60	1.81	33.3
Wheat	60	1.90	33.3
Flaxseed	56	1.65	35.7

TABLE 7. COST OF 100 POUNDS OF FEED AT A GIVEN PRICE AND WEIGHT PER BUSHEL

This table is to aid in comparing feeds on a 100-pound basis and in determining the cost of a ration. If it is desired to find the cost of 100 pounds of oats when it sells for 30 cents per bushel, follow down the column under the heading "Price per bushel" until the number 30 is reached; then to the right to the column headed "32" because there are 32 pounds to a bushel, where 94 cents is given as the price of 100 pounds of oats. Prices per bushel are often misleading because of the differences in bushel weights. Ear corn at 50 cents per bushel figures 71 cents per 100 pounds, while oats at 30 cents per bushel cost 94 cents per 100 pounds.

Price per bushel	Cost per 100 pounds when a bushel weighs				
	32 lbs. (Oats)	48 lbs. (Barley)	56 lbs. (Shelled corn or rye)	60 lbs. (Soybeans or wheat)	70 lbs. (Ear corn)
$0.10	$0.31	$0.21	$0.18	$0.17	$0.14
.11	.34	.23	.20	.18	.16
.12	.38	.25	.21	.20	.17
.13	.41	.27	.23	.22	.19
.14	.44	.29	.25	.23	.20
.15	.47	.31	.27	.25	.21
.16	.50	.33	.29	.27	.23
.17	.53	.35	.30	.28	.24
.18	.56	.37	.32	.30	.26
.19	.59	.40	.34	.32	.27
.20	.63	.42	.36	.33	.29
.21	.66	.44	.38	.35	.30
.22	.69	.46	.39	.37	.31
.23	.72	.48	.41	.38	.33
.24	.75	.50	.43	.40	.34
.25	.78	.52	.45	.42	.36
.26	.81	.54	.46	.43	.37
.27	.84	.56	.48	.45	.39
.28	.88	.58	.50	.47	.40
.29	.91	.60	.52	.48	.41
.30	.94	.62	.54	.50	.43
.31	.97	.65	.55	.52	.44
.32	1.00	.67	.57	.53	.46
.33	1.03	.69	.59	.55	.47
.34	1.06	.71	.61	.57	.49
.35	1.09	.73	.63	.58	.50
.36	1.13	.75	.64	.60	.51
.37	1.16	.77	.66	.62	.53
.38	1.19	.79	.68	.63	.54
.39	1.22	.81	.70	.65	.56
.40	1.25	.83	.71	.67	.57
.41	1.28	.85	.73	.68	.59
.42	1.31	.87	.75	.70	.60
.43	1.34	.90	.77	.72	.61
.44	1.38	.92	.79	.73	.63
.45	1.41	.94	.80	.75	.64
.46	1.44	.96	.82	.77	.66
.47	1.47	.98	.84	.78	.67
.48	1.50	1.00	.86	.80	.69
.49	1.53	1.02	.88	.82	.70
.50	1.56	1.04	.89	.83	.71
.51	1.59	1.06	.91	.85	.73
.52	1.63	1.08	.93	.87	.74
.53	1.66	1.10	.95	.88	.76
.54	1.69	1.12	.96	.90	.77
.55	1.72	1.15	.98	.92	.79
.56	1.75	1.17	1.00	.93	.80
.57	1.78	1.19	1.02	.95	.81
.58	1.81	1.21	1.04	.97	.83
.59	1.84	1.23	1.05	.98	.84
.60	1.88	1.25	1.07	1.00	.86
.61	1.91	1.27	1.09	1.02	.87
.62	1.94	1.29	1.11	1.03	.89
.63	1.97	1.31	1.13	1.05	.90
.64	2.00	1.33	1.14	1.07	.91
.65	2.03	1.35	1.16	1.08	.93
.66	2.06	1.37	1.18	1.10	.94
.67	2.09	1.40	1.20	1.12	.96
.68	2.13	1.42	1.21	1.13	.97
.69	2.16	1.44	1.23	1.15	.99

TABLE 7. (Continued)

Price per bushel	Cost per 100 pounds when a bushel weighs				
	32 lbs.	48 lbs.	56 lbs.	60 lbs.	70 lbs.
	(Oats)	(Barley)	(Shelled corn or rye)	(Soybeans or wheat)	(Ear corn)
.70	2.19	1.46	1.25	1.17	1.00
.71	2.22	1.48	1.27	1.18	1.01
.72	2.25	1.50	1.29	1.20	1.03
.73	2.28	1.52	1.30	1.22	1.04
.74	2.31	1.54	1.32	1.23	1.06
.75	2.34	1.56	1.34	1.25	1.07
.76	2.38	1.58	1.36	1.27	1.09
.77	2.41	1.60	1.38	1.28	1.10
.78	2.44	1.62	1.39	1.30	1.11
.79	2.47	1.65	1.41	1.32	1.13
.80	2.50	1.67	1.43	1.33	1.14
.81	2.53	1.69	1.45	1.35	1.16
.82	2.56	1.71	1.46	1.37	1.17
.83	2.59	1.73	1.48	1.38	1.19
.84	2.63	1.75	1.50	1.40	1.20
.85	2.66	1.77	1.52	1.42	1.21
.86	2.69	1.79	1.54	1.43	1.23
.87	2.72	1.81	1.55	1.45	1.24
.88	2.75	1.83	1.57	1.47	1.26
.89	2.78	1.85	1.59	1.48	1.27
.90	2.81	1.87	1.61	1.50	1.29
.91	2.84	1.90	1.63	1.52	1.30
.92	2.88	1.92	1.64	1.53	1.31
.93	2.91	1.94	1.66	1.55	1.33
.94	2.94	1.96	1.68	1.57	1.34
.95	2.97	1.98	1.70	1.58	1.36
.96	3.00	2.00	1.71	1.60	1.37
.97	3.03	2.02	1.73	1.62	1.39
.98	3.06	2.04	1.75	1.63	1.40
.99	3.09	2.06	1.77	1.65	1.41
1.00	3.13	2.08	1.79	1.67	1.43
1.01	3.16	2.10	1.80	1.68	1.44
1.02	3.19	2.12	1.82	1.70	1.46
1.03	3.22	2.15	1.84	1.72	1.47
1.04	3.25	2.17	1.86	1.73	1.49
1.05	3.28	2.19	1.88	1.75	1.50
1.06	3.31	2.21	1.89	1.77	1.51
1.07	3.34	2.23	1.91	1.78	1.53
1.08	3.38	2.25	1.93	1.80	1.54
1.09	3.41	2.27	1.95	1.82	1.56
1.10	3.44	2.29	1.96	1.83	1.57
1.11	3.47	2.31	1.98	1.85	1.59
1.12	3.50	2.33	2.00	1.87	1.60
1.13	3.53	2.35	2.02	1.88	1.61
1.14	3.56	2.38	2.04	1.90	1.63
1.15	3.59	2.40	2.05	1.92	1.64
1.16	3.63	2.42	2.07	1.93	1.66
1.17	3.66	2.44	2.09	1.95	1.67
1.18	3.69	2.46	2.11	1.97	1.69
1.19	3.72	2.48	2.13	1.98	1.70
1.20	3.75	2.50	2.14	2.00	1.71

USE OF TABLES 8 AND 9

Tables 8 and 9 give the comparative prices of digestible protein and total digestible nutrients in some common feeds at varying prices per ton. For example, to compare the cost of digestible protein in cottonseed meal at $44 a ton with soybean oilmeal at $40 a ton, follow across the line after cottonseed meal to the column headed "44" in table 8 and you find the figure 5.8. In the same manner follow from soybean oilmeal to the column headed "40" and you find the figure 5.3. That means that 1 pound of digestible protein in cottonseed meal at $44 a ton costs 5.8 cents and 1 pound in soybean oilmeal at $40 costs 5.3 cents. In a similar manner the costs per pound of total digestible nutrients at different prices can be checked in table 9.

TABLE 8. COMPARATIVE COST PER POUND OF DIGESTIBLE PROTEIN IN FEEDS

Feeds	Digestible protein in 100 lbs. of feed	Cost of feed per ton, dollars																						
		6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	44	48	52	56	60
	(lbs.)	Cost of 1 pound of digestible protein, cents																						
Alfalfa hay	10.6	2.8	3.8	4.7	5.7	6.6	7.5	8.5	9.4	10.4	11.3	12.3	13.2	14.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Barley	9.3	3.2	4.3	5.4	6.5	7.5	8.6	9.7	10.8	11.8	12.9	14.0	15.1	16.1	17.2	18.3	19.4	20.4	21.5	23.7	25.8	28.0	30.1	32.3
Corn, dent	7.4	4.1	5.4	6.8	8.1	9.5	10.8	12.2	13.5	14.9	16.2	17.6	18.9	20.3	21.6	23.0	24.3	25.7	27.0	29.7	32.4	35.1	37.8	40.5
Corn gluten feed	22.7	1.3	1.8	2.2	2.6	3.1	3.5	4.0	4.4	4.8	5.3	5.7	6.2	6.6	7.0	7.5	7.9	8.4	8.8	9.7	10.6	11.5	12.3	13.2
Corn gluten meal	36.5	0.8	1.1	1.4	1.6	1.9	2.2	2.5	2.7	3.0	3.3	3.6	3.8	4.1	4.4	4.7	4.9	5.2	5.5	6.0	6.6	7.1	7.7	8.2
Cottonseed meal	37.8	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.6	2.9	3.2	3.4	3.7	4.0	4.2	4.5	4.8	5.0	5.3	5.8	6.3	6.9	7.4	7.9
Linseed meal (37% and over)	33.5	1.0	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.6	7.2	7.8	8.4	9.0
Oats	9.4	3.2	4.3	5.3	6.4	7.4	8.5	9.6	10.6	11.7	12.8	13.8	14.9	16.0	17.0	18.1	19.1	20.2	21.3	23.4	25.5	27.7	29.8	31.9
Red clover hay	7.0	4.3	5.7	7.1	8.6	10.0	11.4	12.9	14.3	15.7	17.1	18.6	20.0	21.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Soybeans	32.8	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.7	7.3	7.9	8.5	9.1
Soybean hay	11.1	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	19.8	21.6	23.4	25.2	27.0
Soybean oilmeal	37.7	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.4	3.7	4.0	4.2	4.5	4.8	5.0	5.3	5.8	6.4	6.9	7.4	8.0
Timothy hay	2.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5	37.9	41.4	44.8	48.3	51.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wheat	11.3	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8	9.7	10.6	11.5	12.4	13.3	14.2	15.0	15.8	16.8	17.7	19.5	21.2	23.0	24.7	26.5
Wheat bran	13.1	2.3	3.1	3.8	4.6	5.3	6.1	6.9	7.6	8.4	9.2	9.9	10.7	11.5	12.2	13.0	13.7	14.5	15.3	16.8	18.3	19.8	21.4	22.9

TABLE 9. COMPARATIVE COST PER POUND OF TOTAL DIGESTIBLE NUTRIENTS IN FEEDS

Feeds	Total digestible nutrients in 100 lbs. of feed	Cost of feed per ton, dollars																							
		5	6	7	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	(lbs.)	Cost of 1 pound digestible nutrients, cents																								
Alfalfa hay	50.3	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Barley	78.7	0.3	0.4	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.2
Beet pulp	71.8	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3.1	3.2	3.3	3.5
Corn, dent	83.7	0.3	0.4	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.6	2.7	2.9	3.0
Molasses, cane	56.6	0.4	0.5	0.6	0.7	0.9	1.1	1.2	1.4	1.6	1.8	1.9	2.1	2.3	2.5	2.7	2.8	3.0	3.2	3.4	3.5	3.7	3.9	4.1	4.2	4.4
Oats	71.5	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.5	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.4	3.5
Rye	80.1	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2	1.4	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.7	2.9	3.0	3.1
Red clover hay	51.9	0.5	0.6	0.7	0.8	1.0	1.2	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Soybean hay	50.6	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.3	4.5	4.7	4.9
Timothy hay	46.9	0.5	0.6	0.7	0.9	1 1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wheat	83.6	0.3	0.4	0.4	0.5	0 6	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.0
Wheat bran	70.2	0.4	0.4	0.5	0.6	0 7	0.9	1.0	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.6	2.7	2.8	3.0	3.1	3.3	3.4	3.6

TABLE 10. NUTRIENTS IN 100 POUNDS OF COMMON FEEDS
(From Morrison's "Feeds and Feeding," 20th Edition)

Feeds	*Total protein (lbs.)	Digestible protein (lbs.)	†Total digestible nutrients (lbs.)
CONCENTRATES			
Barley	11.8	9.3	78.7
Beet pulp, dried	9.0	4.8	71.8
Brewers' grain, dried	26.5	20.7	65.3
Corn-and-cob meal	8.2	6.0	75.9
Corn, dent	9.7	7.4	83.7
Corn gluten feed	26.4	22.7	77.4
Corn gluten meal	42.9	36.5	81.8
Cottonseed meal	45.6	37.8	80.8
Distillers' grain, dried from corn	30.6	22.3	85.0
Distillers' grain, dried from rye	18.1	10.1	62.9
Flaxseed	23.5	21.4	108.7
Linseed meal	35.2	30.6	78.2
Linseed meal (37% protein or over)	38.5	33.5	77.8
Malt sprouts	26.4	20.3	70.6
Molasses, cane	2.8	0.9	56.6
Oats	12.0	9.4	71.5
Oats, lightweight	12.3	7.8	60.6
Rye	12.3	10.3	80.1
Soybeans	36.9	32.8	86.2
Soybean oilmeal	44.3	37.7	82.2
Tankage (60%)	61.3	56.4	78.0
Wheat bran	15.8	13.1	70.2
Wheat shorts (brown)	17.8	15.1	76.3
Wheat	13.1	11.3	83.6
DRY ROUGHAGES			
Alfalfa	14.7	10.6	50.3
Clover, red	11.8	7.0	51.9
Clover and timothy (½ of each)	8.6	4.4	48.0
Corn fodder	6.7	3.5	54.6
Corn stover	5.7	2.1	46.2
Oat hay	8.3	4.5	46.3
Oat straw	4.0	0.9	44.1
Prairie hay	5.7	2.6	49.2
Sorghum fodder	6.4	3.6	52.7
Soybean hay	14.8	11.1	50.6
Soybean straw	4.0	0.9	36.5
Sudan grass hay	8.8	4.3	48.5
Sweetclover hay	14.0	10.5	49.9
Timothy hay	6.2	2.9	46.9
SUCCULENT FEEDS			
Alfalfa, green	4.6	3.4	14.7
Beet pulp, wet	1.5	0.8	8.9
Bluegrass, green	4.2	2.4	18.6
Brewers' grains, wet	5.7	4.6	16.6
Corn cannery refuse	2.0	1.1	11.5
Mangels	1.4	1.0	7.3
Silage, alfalfa (wilted)	10.0	5.1	29.0
Silage, alfalfa (high in water)	3.7	1.9	12.7
Silage, corn	2.3	1.3	18.7
Silage, sorghum (grain)	2.1	1.1	17.8
Silage, sorghum (sweet)	1.5	0.8	15.1
Silage, soybean	4.2	2.6	15.0
Sugar beet tops	3.5	1.8	11.8

*This column is for comparison of feeds that are offered for sale. Use digestible protein for balancing rations.
†This is the total of the digestible protein and the carbohydrates, plus the fats multiplied by 2.25.